ERDC TN-DOER-C25
December 2001

Manufactured Soil Field Demonstrations on Brownfields and Abandoned Minelands

PURPOSE: The purpose of this technical note is to describe the use of dredged material in manufacturing topsoil for restoration of brownfields and abandoned acid minelands.

BACKGROUND: The U.S. Army Corps of Engineers has the responsibility to maintain navigation in all harbors and waterways across the United States. This task requires the dredging of more than 300 million cu m (300 million cubic yards) of sediment from the waterways annually. Places to dispose of these vast amounts of sediment are required. Dredged material that is not suitable for open-water disposal usually is placed in confined disposal facilities (CDFs). Current CDFs are filling up, and new CDFs are difficult to locate. In an effort to provide storage capacity for future dredging, dredged material in CDFs is being evaluated for beneficial uses. Cooperative research and development agreements (CRDAs) have been established between the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, and specific innovative technologies to develop and demonstrate the application of these technologies to the reclamation and reuse of dredged material from existing CDFs. CRDAs have been established using recycled soil manufacturing technology (RSMT) with N-Viro International (reconditioned sewage sludge biosolids), Bion Environmental Technologies, Inc. (reconditioned animal manures), and Advanced Remedial Mixing, Inc. (blending equipment for reclamation of dredged material and other residuals). Examples of the reclamation and reuse of dredged material include manufactured topsoil for landscaping, acid mine drainage remediation, mineland restoration, brownfield redevelopment, Superfund restoration, landfill cover, and constructed wetlands for improvement of water quality.

INTRODUCTION: ERDC teamed with the Carnegie-Mellon University Brownfields Center (CMU-BC) in Pittsburgh, PA, to train candidate students for employment in Brownfield Redevelopment Projects under a U.S. Environmental Protection Agency (USEPA) Education Grant to CMU-BC. Training included innovative technologies that could be applied to USEPA brownfield redevelopment sites. Student trainees learned about the technology through classroom lectures and hands-on laboratory work and finally hands-on field work. The result of the training was employment with private companies involved in brownfield redevelopment. One of the innovative technologies selected for the training program was the beneficial use of dredged material as topsoil according to RSMT at Brownfield redevelopment sites. Two sites were selected: Nine Mile Run Brownfield Site in Pittsburgh, PA, and an abandoned acid mine drainage site at Vintondale, PA.

METHODS: Training for the program started with classroom lectures on the technologies to be used (Figure 1). Student trainees learned the principles behind the technologies to be applied to brownfield redevelopment. Ms. Nancy Taylor, U.S. Army Engineer District, Pittsburgh, explained the Corps role in dredging waterways and the management and disposal of dredged material. The potential for beneficial use of the dredged material at brownfield sites was discussed (Figure 1). After classroom training, the students conducted laboratory hands-on exercises blending dredged material with residual waste paper fiber and biosolids. Finally, the students along with community

Figure1. Classroom lecture to USEPA brownfield student trainees

volunteers actually blended dredged material with residual waste materials according to RSMT at two field locations to get hands-on field experience in applying the technology. The two field sites selected were located in Pittsburgh, PA, and Vintondale, PA.

Pittsburgh, PA. Dredged material from a CDF at Donora, PA, was used to manufacture topsoil on a brownfield site in Pittsburgh that was an old steel-producing industrial complex. The site was a slag pile approximately 60 m (200 ft) high and over 300 m (1,000 ft) long adjacent to Nine Mile Run creek. The city of Pittsburgh desired to redevelop the site for multiple housing complexes. Bench-scale tests were conducted at ERDC using RSMT to blend dredged material, slag, cellulose (residual waste paper), and biosolids (BionSoil®). Ryegrass was grown in the blends to determine the blend that gave the best plant growth (Figure 2).

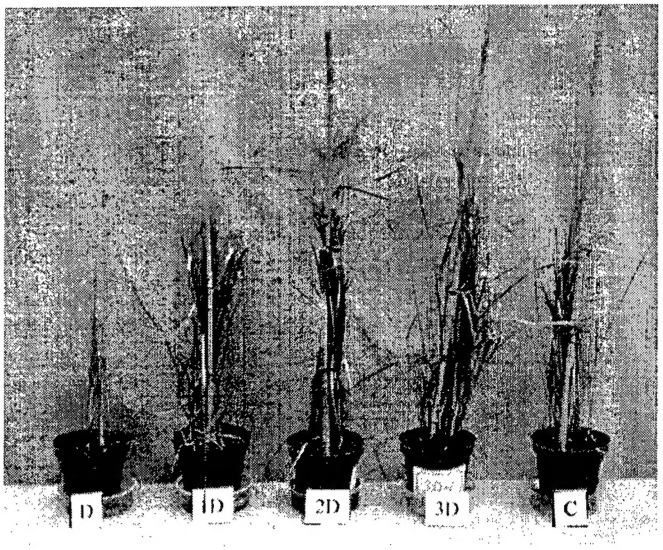

Figure 2. Ryegrass growth in Donora dredged material (D), and RSMT blended topsoils (1D, 2D, 3D), and fertile potting soil control (C)

Blends 1D, 2D, or 3D grew as well as or better than the control. Blend 1D was used in a field pilot demonstration at Nine Mile Run brownfield site because it contained less dredged material and was less expensive to transport to the site.

Dr. Rick Stehouwer, Pennsylvania State University, University Park, was in charge of establishing a field demonstration plot at Nine Mile Run. The total field demonstration plot area was 21 by 27 m (69 by 87 ft), 558 sq m (6003 sq ft), 0.056 ha (0.14 acre) with 0.9-m- (3-ft-) wide pathways between all plots. Amendments and total quantity delivered were 4 cu m (5 cu yd) of each material. Amendments were either mixed with slag to a depth of 102-152 mm (4-6 in.) or mixtures of amendments were surface applied according to Figure 3.

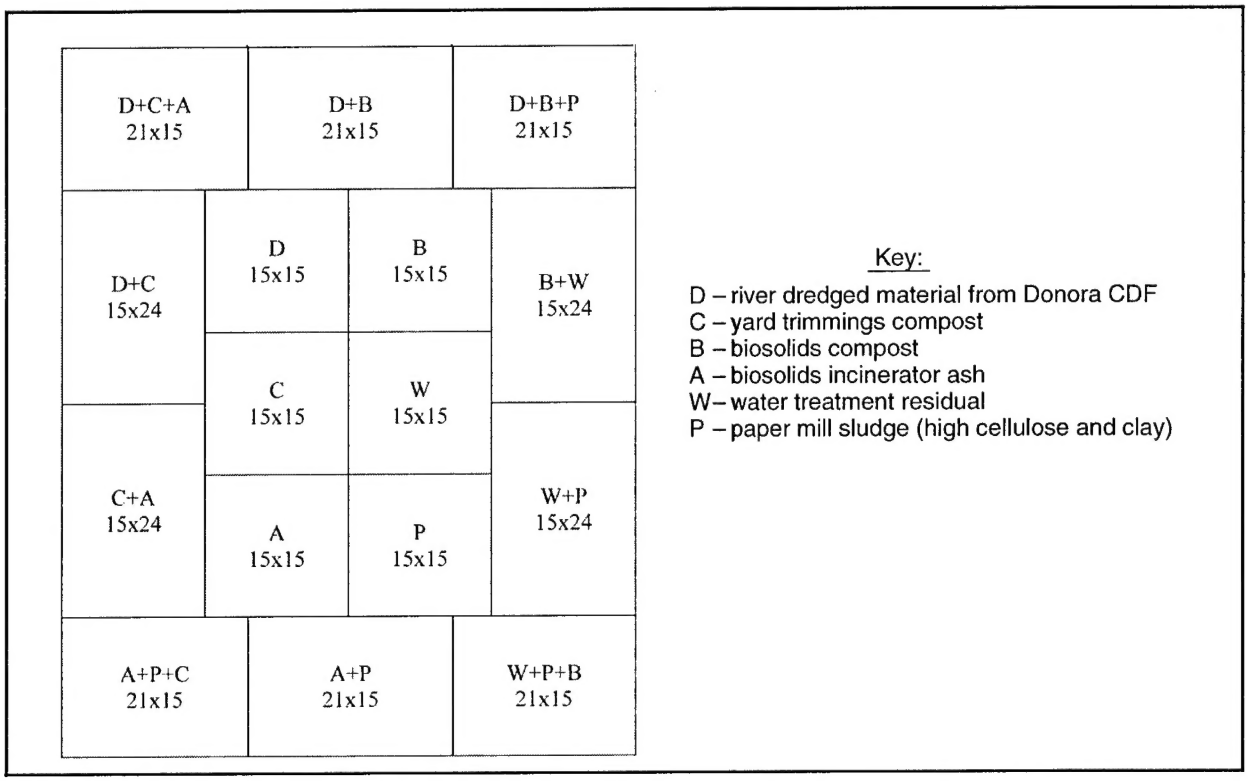

Figure 3. Application of amendments, Nine Mile Run field demonstration plot

All plots were seeded with a mixture of annual ryegrass, tall fescue, and red clover, and covered with a straw mulch. Figure 4 shows the plots in August 2001, 3 months after seeding.

The blended RSMT dredged material topsoil was incorporated into the slag and produced the best plant growth under field conditions compared with other mixtures of residual waste materials. These results demonstrated clearly that dredged material can be blended into topsoil with residual waste materials such as waste paper fiber, slag, and biosolids to restore and vegetate brownfield sites on old industrial steel mill sites (Figures 5 and 6).

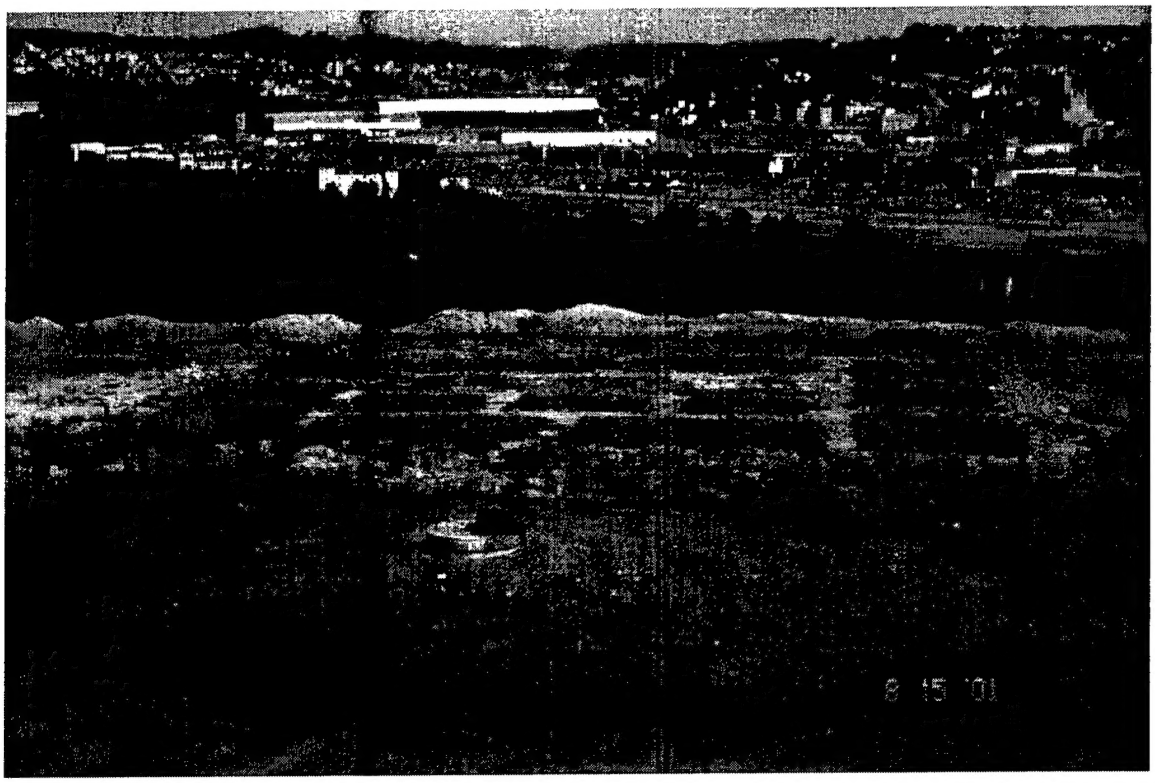

Figure 4. Demonstration plots at Nine Mile Run slag pile 3 months after seeding (rectangular plots center of picture)

Figure 5. Dredged material, yard waste, and biosolids incinerator ash plot

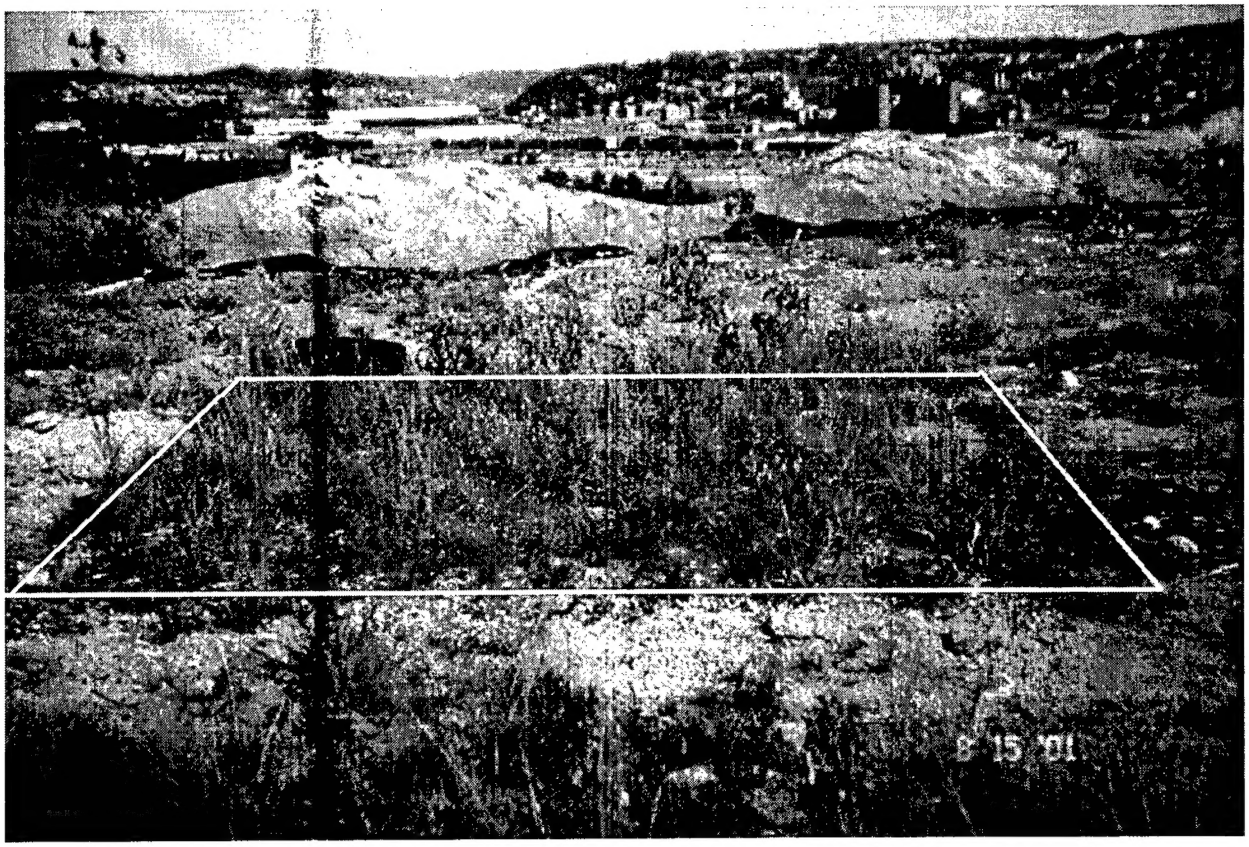

Figure 6. Dredged material, paper fiber, and biosolids compost

Vintondale, PA. Dredged material from the Donora CDF was used to manufacture a topsoil for use in abandoned mineland restoration. Bench-scale tests were conducted at ERDC applying RSMT procedures to dredged material, residual bony material (coal mine overburden) at the abandoned acid mine drainage site at Vintondale, PA, residual waste paper fiber, BionSoil®, lime, and fertlizer (Figures 7 and 8).

RSMT blends 1BD and 2BD resulted in higher yields than the fertile commercial potting soil. Blend 1BD was selected for the field demonstration at Vintondale because it contained lower amounts of dredged material and therefore the cost of transporting the dredged material to the site was lower.

Figure 7. RSMT screening test in greenhouse

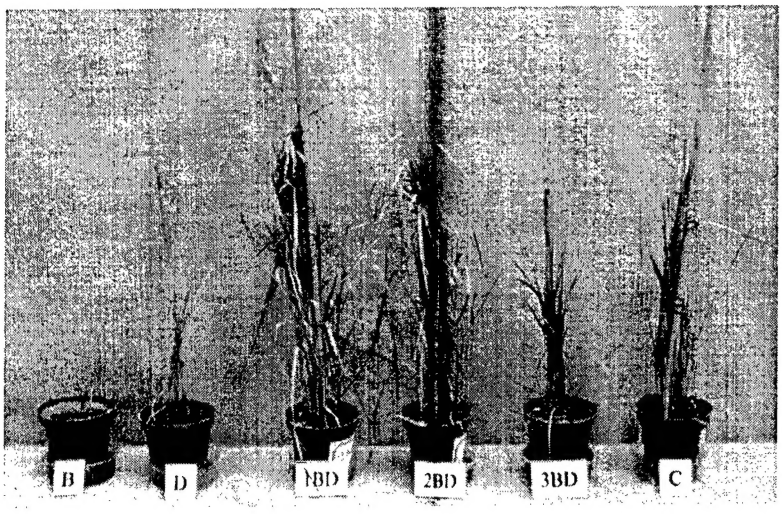

Figure 8. Ryegrass growth in bony material (B), dredged material (D), combinations of RSMT blends (1BD, 2BD, 3BD), and a fertile commercial potting soil (C)

The field site at Vintondale was approximately 8 ha (20 acres). Four hectares (10 acres) of bony residual acid mine waste was scheduled for restoration with 5,000 trees and shrubs. RSMT blended topsoil was used to plant each tree and shrub in the existing bony residual material. The blend was essentially prepared in a wheel barrow for each tree or shrub. Waste paper fiber was placed in the wheelbarrow first (Figure 9), fertilizer was spread over the paper fiber (Figure 10), then residual bony material was spread over the fertilized paper fiber (Figure 11), lime was spread over the residual bony material (Figure 12), and dredged material was placed on top of the limed residual bony material (Figure 13). This layering of materials was repeated three times to fill the wheelbarrow to make up the selected RSMT 1BD blend (Figure 14). The wheelbarrow of layered blend was then shoveled into the planting hole for the tree or shrub. Part of the blend was placed below the tree or shrub (Figure 15), with the rest of the blend around the sides (Figure 16) and on top of the tree or shrub balled root (Figure 17). Surrounding the tree or shrub root with good topsoil will give the tree/shrub an improved initial start at establishment.

Students and volunteers planted all of the trees and shrubs using this procedure. The entire 4 ha (10 acres) was planted in 4 days (Figure 18). Success rate of the planted trees and shrubs has been over 90 percent in the first 4 months since transplanting (Figures 19 and 20). The restored site will be observed for the next year to evaluate the further success of the RSMT beneficial use of dredged material at the site.

CONCLUSIONS AND RECOMMENDATIONS: Dredged material was shown to be very effective in the restoration of both a brownfield site in Pittsburgh, PA, and an abandoned acid mine drainage site at Vintondale, PA, in the short term. These applications of recycled soil manufacturing technology using dredged material and available residual waste material such as paper fiber and biosolids such as Biosolids compost, Biosolids incinerator ash, or BionSoil® were overwhelming successes and can be recommended for application at similar brownfield redevelopment and abandoned acid mine drainage sites.

ACKNOWLEDGEMENTS: This research was supported by the U.S. Army Engineer District, Pittsburgh, Mr. Jim Sekela and Mr. Hank Edwardo, points of contact. The demonstration was conducted in cooperation with AgRecycle, Inc., Mr. Dan Eichenlaub; CMU Brownfield Center, Dr. Debra Lange, Director; AMD & ART, Inc., Shannon Peterson and Jessica Johnson; and Bion Technologies, Inc., Jim Navworski. Greenhouse screening tests were conducted by Dr. Tom Sturgis, Environmental Laboratory, U.S. Army Engineer Research and Development Center (ERDC), with technical assistance from Messrs. Jim Cole and Henry Banks, Dyntel Corporation. Support for

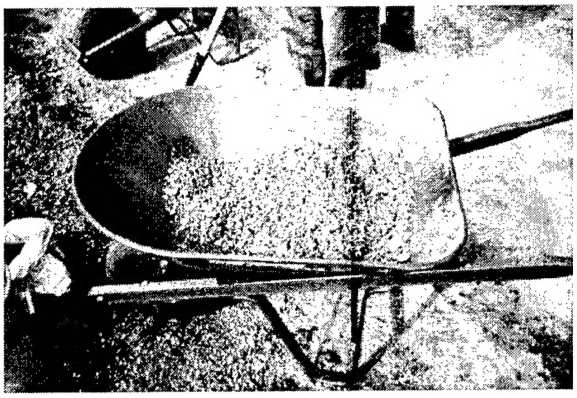

Figure 9. Waste paper fiber added

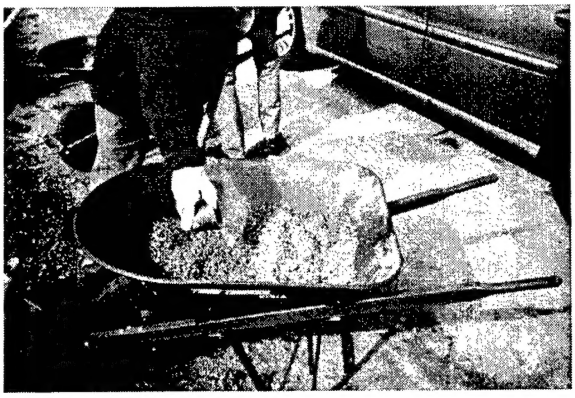

Figure 10. Fertililzer added

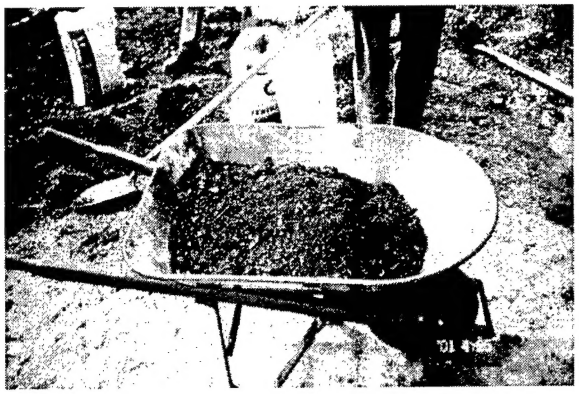

Figure 11. Bony material added

Figure 12. Lime added

Figure 13. Dredged material added

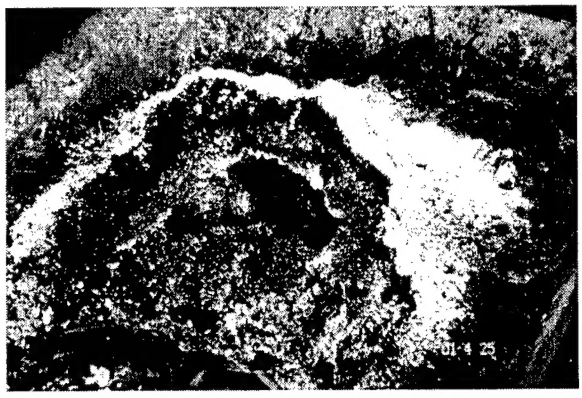

Figure 14. Layered 1BD blend

Figure 15. RSMT blend being placed in hole under tree root ball

Figure 16. Blend placed around tree root ball

Figure 17. Filling in with bony material

Figure 18. Overall view of planting

Figure 19. Vegetation after 4 months

Figure 20. Vegetated slope

ERDC participation was under the DOER Program Work Unit 33298, entitled "Field Operations for Recoverable Dredged Material at CDFs."

DISCLAIMER: Any material or equipment equivalent to those mentioned in this technical note can also be used in manufacturing topsoil for brownfield redevelopment.

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> Lee, C. R. (2001). "Manufactured soil field demonstrations on brownfields and abandoned minelands," *DOER Technical Notes Collection* (ERDC TN-DOER-C25), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/dots/doer*